

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference <b>KN8357-E. MJN</b>	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. <b>PCT/EP 98/ 07738</b>	International filing date (day/month/year) <b>30/11/1998</b>	Priority date (day/month/year) <b>28/11/1997</b>
International Patent Classification (IPC) or national classification and IPC <b>H02K3/00</b>		
Applicant <del>ASEA BROWN BOVERI AB</del> et al. <b>ABB AB</b>		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.


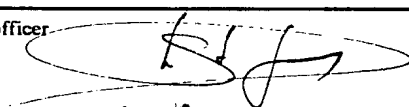
2. This **REPORT** consists of a total of 6 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consists of a total of 7 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand <b>11/06/1999</b>	Date of completion of this report <b>01.03.00</b>
Name and mailing address of the IPEA:  European Patent Office D-80298 Munich Tel. (+49-89) 2399-0, Tx: 523656 epmu d Fax: (+49-89) 2399-4465	Authorized officer:  <b>F. LG Guay</b> Telephone No. (+49-89) 2399-2637

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/EP98/07738

## I. Basis of the report

1. This report has been drawn up on the basis of *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.)*

☐ the international application as originally filed

☒ the description, pages 1 - 25, as originally filed  
 pages, filed with the demand  
 pages, filed with the letter of

☒ the claims, Nos., as originally filed  
 Nos., as amended under Article 19  
 Nos., filed with the demand  
 Nos. 1 - 40, filed with the letter of 24.01.00

☒ the drawings, sheets / fig., as originally filed  
 sheets / fig., filed with the demand  
 sheets / fig. 1/1, filed with the letter of 24.01.00

2. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.
- ☐ the drawings, sheets / fig.

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2 (c)).

4. Additional observations, if necessary:

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement****1. Statement**

Novelty	Claims	1-40	YES
	Claims	None	NO
Inventive Step	Claims	None	YES
	Claims	1-40	NO
Industrial Applicability	Claims	1-40	YES
	Claims	None	NO

**2. Citations and Explanations****1. Concerning Claims 1 to 3 and 5 :**

Document US-A-5036165 discloses a high voltage cable (100) which has been specifically designed to be wound in slots of a stator winding of an electric machine as several times stated in the description (see for instance column 1, lines 25, 26 and column 1, lines 31, 32 as well as in the abstract). Cable (100) comprises conductor means (conductive strands 102) having an inner and an outer semi-conducting layer (semi-conductive layers 104 and 105) and an intermediate insulating layer (insulation 106). Moreover, said inner semi-conductive layer is electrically connected to the conductor means (see column 2, lines 36-37) and said outer semi-conductive layer is grounded (see column 2, lines 41-43).

Considering now document US.A -4091298, the latter discloses a high voltage rotating electric machine comprising a rotor (11), obviously a stator and a winding having electrically conducting means (rod 36) and cooling means (see column 3, lines 21-28).

Both documents belonging to the same technical field, they may be combined by the man skilled in the art to obviously arrive at the machine of claims 1 to 3 and 5 which therefore lack an inventive step in terms of Article 33 (3) PCT.

**2. Concerning Independent Claim 37:**

See part VIII.

3. Concerning the remaining dependent claims:

The additional feature disclosed in these claims is either known from the cited documents or appears to be easily available to the skilled person without the exercise of any inventive activity.

It is therefore assumed that claims 1, 6 to 36 and 38 to 40 also lack a inventive step in terms of Article 33 (3) PCT.

**VII. Certain defects in the international application**

The following defects in the form or contents of the international application have been noted:

1. Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the documents US-A-5036165 and US-A-4091298 is not mentioned in the description, nor are these documents identified therein.
2. According to the requirements of Rule 11.13(m) PCT the same feature shall be denoted by the same reference sign throughout the application. This requirement is not met in view of the cable to which reference number 2 has been given, page 18, line 21 and reference number 1, page 22, lines 1 and 22.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)


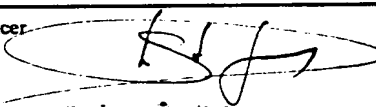
Applicant's or agent's file reference <b>KN8357-E. MJN</b>		FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. <b>PCT/EP 98/ 07738</b>	International filing date (day/month/year) <b>30/11/1998</b>	Priority date (day/month/year) <b>28/11/1997</b>	
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Applicant <b>ASEA-BROWN BOVERI AB et al. ABB AB</b>			

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☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).  
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- VIII ☒ Certain observations on the international application

**CORRECTED  
VERSION**

Date of submission of the demand <b>11/06/1999</b>	Date of completion of this report <b>01.03.00</b>
Name and mailing address of the IPEA:  European Patent Office D-80298 Munich Tel. (+49-89) 2399-0, Tx: 523656 epmu d Fax: (+49-89) 2399-4465	Authorized officer:  <b>F. G. Gray</b> Telephone No. (+49-89) 2399-2637

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/EP98/07738

## I. Basis of the report

1. This report has been drawn up on the basis of (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*)

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# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/EP98/07738

## V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

### 1. Statement

Novelty	Claims	1-40	YES
	Claims	None	NO
Inventive Step	Claims	None	YES
	Claims	1-40	NO
Industrial Applicability	Claims	1-40	YES
	Claims	None	NO

### 2. Citations and Explanations

#### 1. Concerning Claims 1 to 3 and 5:

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See part VIII.



3. Concerning the remaining dependent claims:

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It is therefore assumed that claims 1, 6 to 36 and 38 to 40 also lack a inventive step in terms of Article 33 (3) PCT.

**VII. Certain defects in the international application**

The following defects in the form or contents of the international application have been noted:

1. Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the documents US-A-5036165 and US-A-4091298 is not mentioned in the description, nor are these documents identified therein.
2. According to the requirements of Rule 11.13(m) PCT the same feature shall be denoted by the same reference sign throughout the application. This requirement is not met in view of the cable to which reference number 2 has been given, page 18, line 21 and reference number 1, page 22, lines 1 and 22.

**VIII. Certain observations on the international application**

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

1. Claim 37 does not meet the requirements of Article 6 PCT in that the matter for which protection is sought is not clearly defined. The claim attempts to define the subject-matter in terms of the result to be achieved which merely amounts to a statement of the underlying problem. The technical features necessary for achieving this result should be added.

**VIII. Certain observations on the international application**

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

1. Claim 37 does not meet the requirements of Article 6 PCT in that the matter for which protection is sought is not clearly defined. The claim attempts to define the subject-matter in terms of the result to be achieved which merely amounts to a statement of the underlying problem. The technical features necessary for achieving this result should be added.

CLAIMS

1. A high voltage rotating electric machine comprising a stator (6), a rotor (7) and at least one winding (1) wound on the stator having inner electrically  
5 conducting means (3) and surrounding electrical insulation (4), characterised in that said electrically conducting means comprises conductor means (32) and cooling means (31) for cooling the conductor means (32) to improve the electrical conductivity of the conductor means, and in that  
10 said electrical insulation (4) is solid and comprises spaced apart inner and outer layers (35, 36) each having semiconducting properties and, between said inner and outer layers, an intermediate layer (37) of electrically insulating material.
- 15 2. An electric machine according to claim 1, characterised in that the said semiconducting inner layer (35) is electrically connected to, so as to be at substantially the same electric potential as, the conductor means (32).
- 20 3. An electric machine according to claim 1 or 2, characterised in that the said semiconducting outer layer (36) is connected to a controlled electric potential along its length.
- 25 4. An electric machine according to claim 3, characterised in that the said semiconducting outer layer (36) is connected to said controlled electric potential at spaced apart regions along the length of the outer layer.
- 30 5. An electric machine according to claim 3 or 4, characterised in that the said controlled electric potential is earth potential.
6. An electric machine according to claim 5, characterised in that, with connection of the semiconducting outer layer (36) to earth potential, the electric field of

the machine both in winding slots (10) and in end winding regions will be near zero.

7. An electric machine according to claim 3 or 4, characterised in that the electric machine has more than one winding wound on the stator and in that a separate controlled potential is selected for each winding.

8. An electric machine according to any one of the preceding claims, characterised in that at least one of said semiconducting inner and outer layers (35, 36) has substantially the same coefficient of thermal expansion ( $\alpha$ ) as that of the said insulating layer (37).

9. An electric machine according to any one of the preceding claims, characterised in that each pair of adjacent layers (35-37) of said electrical insulation are secured to each other along substantially their entire contact surfaces.

10. An electric machine according to any one of the preceding claims, characterised in that the or each winding is in the form of a cable (1).

11. An electric machine according to any one of the preceding claims, characterised in that the said conductor means (32) comprises superconducting means.

12. An electric machine according to claim 11, characterised in that the cooling means comprises central tubular support means (31) for conveying cryogenic coolant fluid, e.g. liquid nitrogen, and in that the superconducting means (32) is of elongate form and is wound around the tubular support means.

13. An electric machine according to claim 11 or 12, characterised in that the said superconducting means comprises high-transition temperature superconducting (or HTS) material.

14. An electric machine according to claim 13 when dependent on claim 12, characterised in that the HTS material comprises HTS tape or wire wound around said tubular support means (31)

5 15. An electric machine according to any one of the preceding claims, characterised in that thermal expansion means (34) are provided between the said electrically conducting means (3) and the said surrounding electrical insulation (34).

10 16. An electric machine according to claim 15, characterised in that said thermal expansion means comprises an expansion gap (34).

15 17. An electric machine according to claim 16, characterised in that the expansion gap (34) comprises a void space.

18. An electric machine according to claim 16, characterised in that the expansion gap (34) is filled with compressible material, e.g. foamed plastics material.

20 19. An electric machine according to claim 18, characterised in that the said compressible material includes electrically conductive or semiconductive material.

20. An electric machine according to any one of the preceding claims, characterised in that thermally insulating means is provided outwardly of the conducting means.

25 21. An electric machine according to any one of the preceding claims, characterised in that the or each winding is wound in stator slots (10) formed in the stator, and in that each stator slot (10) comprises a number of substantially circular cylindrical openings (12) extending axially and radially outside one another, each pair of adjacent openings (12) being joined by a narrower waist portion (13).

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22. An electric machine according to claim 21,  
characterised in that the radii of the said openings (12) of  
each stator slot decrease in a direction towards the rotor  
5 (7).

23. An electric machine according to any of the  
preceding claims, characterised in that the rotating  
electric machine is connectable to one or more system  
voltage levels.

10 24. An electric machine according to claim 23,  
characterised in that one winding is provided with separate  
tappings for connection to different system voltage levels.

25. An electric machine according to claim 23 or 24,  
characterised in that a separate winding is provided for  
15 connection to each system voltage level.

26. An electric machine according to any one of the  
preceding claims, characterised in that the said  
intermediate layer (37) is in close mechanical contact with  
each of said inner and outer layers (35, 36).

20 27. An electric machine according to any one of  
claims 1 to 25, characterised in that the said intermediate  
layer (37) is joined to each of said inner and outer layers  
(35, 36).

28. An electric machine according to claim 27,  
25 characterised in that the strength of the adhesion between  
the said intermediate layer (37) and each of the  
semiconducting inner and outer layers (35, 36) is of the  
same order of magnitude as the intrinsic strength of the  
material of the intermediate layer.

30 29. An electric machine according to claim 26 or 28,  
characterised in that the said layers (35-37) are joined  
together by extrusion.



30. An electric machine according to claim 29, characterised in that the inner and outer layers (35, 36) of semiconducting material and the insulating intermediate layer (37) are applied together over the conducting means  
5 (3) through a multi layer extrusion die.

31. An electric machine according to any one of the preceding claims, characterised in that said inner layer (35) comprises a first plastics material having first electrically conductive particles dispersed therein, said  
10 outer layer (36) comprises a second plastics material having second electrically conductive particles dispersed therein, and said intermediate layer (37) comprises a third plastics material.

32. An electric machine according to claim 31,  
15 characterised in that each of said first, second and third plastics materials comprises an ethylene butyl acrylate copolymer rubber, an ethylene-propylene-diene monomer rubber (EPDM), an ethylene-propylene copolymer rubber (EPR), LDPE, HDPE, PP, PB, PMP, XLPE, EPR or silicone rubber.

20 33. An electric machine according to claim 31 or 32, characterised in that said first, second and third plastics materials have at least substantially the same coefficients of thermal expansion.

25 34. An electric machine according to claim 31, 32 or 33, characterised in that said first, second and third plastics materials are the same material.

35. An electric machine according to any one of the preceding claims, characterised in that it is designed for use at high voltages, suitably in excess of 10 kV, in  
30 particular in excess of 36 kV, and preferably more than 72.5 kV up to very high transmission voltages, such as 400 kV to 800 kV or higher.

36. An electric machine according to any one of the preceding claims, characterised in that it is designed for use at a power range in excess of 0.5 MVA, preferably in excess of 30 MVA and up to 1000 MVA.

5           37. Use of a rotating electric machine according to any one of the preceding claims, characterised in that the machine can be operated with up to 100% overload for a period of time exceeding 15 minutes and up to about two hours.

10           38. Use of a rotating electric machine according to any one of claims 1 to 36, characterised in that the rotating electric machine is directly connected to a power network via connecting devices and without an intermediate transformer between the machine and the network.

15           39. Use of a rotating electric machine according to any one of claims 1 to 36, characterised in that voltage regulation of the rotating electric machine is performed by control of the magnetic field flow through the rotor.

20           40. Use of a rotating electric machine according to any one of claims 1 to 36, characterised in that the machine can be operated without mechanical load and that the machine is provided for compensation of inductive or capacitive load on the network.

Fig. 1

1/1

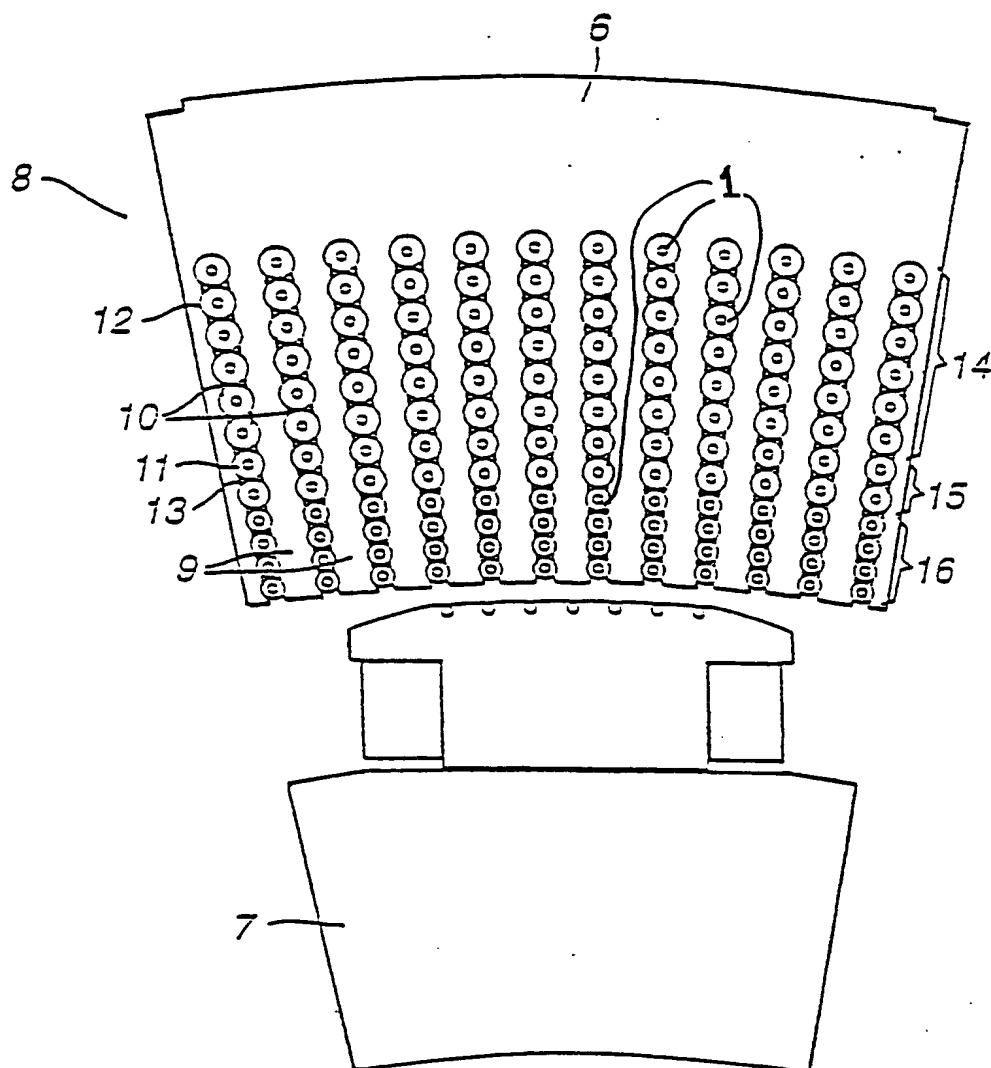
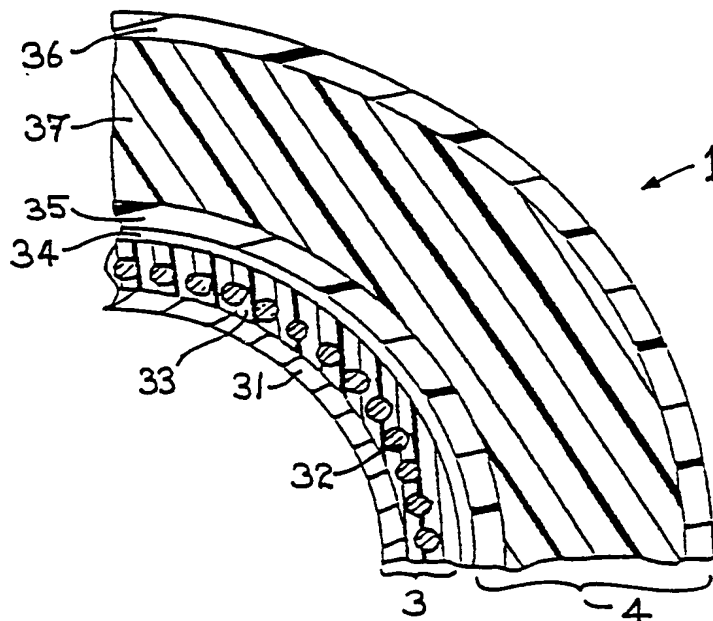


Fig. 2

## PATENT COOPERATION TREATY

PCT

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

United States Patent and Trademark  
Office  
(Box PCT)  
Crystal Plaza 2  
Washington, DC 20231  
ÉTATS-UNIS D'AMÉRIQUE

in its capacity as elected Office

Date of mailing (day/month/year)

14 July 1999 (14.07.99)

International application No.

PCT/EP98/07738

Applicant's or agent's file reference

KN8357-E.MJN

International filing date (day/month/year)

30 November 1998 (30.11.98)

Priority date (day/month/year)

28 November 1997 (28.11.97)

Applicant

LEIJON, Mats

1. The designated Office is hereby notified of its election made:



in the demand filed with the International Preliminary Examining Authority on:

11 June 1999 (11.06.99)



in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was

was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

A. Karkachi

Telephone No.: (41-22) 338.83.38

## PATENT COOPERATION TREATY

PCT

From the INTERNATIONAL BUREAU

NOTIFICATION OF THE RECORDING  
OF A CHANGE(PCT Rule 92bis.1 and  
Administrative Instructions, Section 422)

To:

NEWBY, Martin, John  
J.Y. & G.W. Johnson  
Kingsbourne House  
229-231 High Holborn  
London WC1V 7DP  
ROYAUME-UNI

<b>Date of mailing</b> (day/month/year) 22 July 1999 (22.07.99)	<b>IMPORTANT NOTIFICATION</b>
<b>Applicant's or agent's file reference</b> KN8357-E.MJN	
<b>International application No.</b> PCT/EP98/07738	<b>International filing date</b> (day/month/year) 30 November 1998 (30.11.98)

## 1. The following indications appeared on record concerning:

☒ the applicant
     
 ☐ the inventor
     
 ☐ the agent
     
 ☐ the common representative

<b>Name and Address</b> ASEA BROWN BOVERI AB S-721 78 Västerås Sweden	<b>State of Nationality</b> SE	<b>State of Residence</b> SE
	<b>Telephone No.</b>	
	<b>Facsimile No.</b>	
	<b>Teleprinter No.</b>	

## 2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person
     
 ☐ the name
     
 ☒ the address
     
 ☐ the nationality
     
 ☐ the residence

<b>Name and Address</b> ASEA BROWN BOVERI AB S-721 83 Västerås Sweden	<b>State of Nationality</b> SE	<b>State of Residence</b> SE
	<b>Telephone No.</b>	
	<b>Facsimile No.</b>	
	<b>Teleprinter No.</b>	

## 3. Further observations, if necessary:

## 4. A copy of this notification has been sent to:

<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned
<input checked="" type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:

<b>The International Bureau of WIPO</b> 34, chemin des Colombettes 1211 Geneva 20, Switzerland  Facsimile No.: (41-22) 740.14.35	<b>Authorized officer</b>  Aino Metcalfe  Telephone No.: (41-22) 338.83.38
--	--

## PCT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING  
OF A CHANGE(PCT Rule 92bis.1 and  
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From the INTERNATIONAL BUREAU

To:

NEWBY, Martin, John  
J.Y. & G.W. Johnson  
Kingsbourne House  
229-231 High Holborn  
London WC1V 7DP  
ROYAUME-UNI

Date of mailing (day/month/year)

07 October 1999 (07.10.99)

Applicant's or agent's file reference

KN8357-E.MJN

## IMPORTANT NOTIFICATION

International application No.

PCT/EP98/07738

International filing date (day/month/year)

30 November 1998 (30.11.98)

## 1. The following indications appeared on record concerning:



the applicant



the inventor



the agent



the common representative

Name and Address

ASEA BROWN BOVERI AB  
S-721 83 Västerås  
Sweden

State of Nationality

SE

State of Residence

SE

Telephone No.

Facsimile No.

Teleprinter No.

## 2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:



the person



the name



the address



the nationality



the residence

Name and Address

ABB AB  
S-721 83 Västerås  
Sweden

State of Nationality

SE

State of Residence

SE

Telephone No.

Facsimile No.

Teleprinter No.

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the receiving Office



the International Searching Authority



the International Preliminary Examining Authority



the designated Offices concerned



the elected Offices concerned



other:

The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

Marie-José Devillard

Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

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NOTIFICATION OF THE RECORDING  
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ROYAUME-UNI

<b>Date of mailing</b> (day/month/year) 07 October 1999 (07.10.99)	<b>IMPORTANT NOTIFICATION</b>
<b>Applicant's or agent's file reference</b> KN8357-E.MJN	
<b>International application No.</b> PCT/EP98/07738	<b>International filing date</b> (day/month/year) 30 November 1998 (30.11.98)

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<b>Name and Address</b> ASEA BROWN BOVERI AB S-721 83 Västerås Sweden	<b>State of Nationality</b> SE	<b>State of Residence</b> SE
	<b>Telephone No.</b>	
	<b>Facsimile No.</b>	
	<b>Teleprinter No.</b>	
<b>2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:</b> <input type="checkbox"/> the person <input checked="" type="checkbox"/> the name <input type="checkbox"/> the address <input type="checkbox"/> the nationality <input type="checkbox"/> the residence		
<b>Name and Address</b> ABB AB S-721 83 Västerås Sweden	<b>State of Nationality</b> SE	<b>State of Residence</b> SE
	<b>Telephone No.</b>	
	<b>Facsimile No.</b>	
	<b>Teleprinter No.</b>	
<b>3. Further observations, if necessary:</b>		
<b>4. A copy of this notification has been sent to:</b> <input checked="" type="checkbox"/> the receiving Office <input type="checkbox"/> the designated Offices concerned <input type="checkbox"/> the International Searching Authority <input checked="" type="checkbox"/> the elected Offices concerned <input checked="" type="checkbox"/> the International Preliminary Examining Authority <input type="checkbox"/> other:		

<b>The International Bureau of WIPO</b> 34, chemin des Colombettes 1211 Geneva 20, Switzerland  Facsimile No.: (41-22) 740.14.35	<b>Authorized officer</b>  Marie-José Devillard  Telephone No.: (41-22) 338.83.38
--	---

## PCT

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference <b>KN8357-E.MJN</b>	<b>FOR FURTHER ACTION</b> see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. <b>PCT/EP 98/ 07738</b>	International filing date (day/month/year) <b>30/11/1998</b>	(Earliest) Priority Date (day/month/year) <b>28/11/1997</b>
Applicant <b>ASEA BROWN BOVERI AB et al.</b>		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 2 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

**1. Basis of the report**

- a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

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☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.

☒ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

2

☐ None of the figures.



## INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 98/07738

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 H02K3/22 H02K55/04

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 H02K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 036 165 A (ELTON ET AL.) 30 July 1991 see column 2, line 27 - line 52; figure 1 ---	1,9,26
Y	US 4 091 298 A (GAMBLE) 23 May 1978 see column 3, line 21 - column 4, line 5; figures 2A,2B,2C ---	1,9,26
A	US 4 330 726 A (ALBRIGHT ET AL.) 18 May 1982 see column 4, line 54 - line 65; figure 2 -----	1,9,26

☐

Further documents are listed in the continuation of box C.

☒

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Date of the actual completion of the international search

22 June 1999

Date of mailing of the international search report

30/06/1999

Name and mailing address of the ISA

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Authorized officer

Kempen, P

# INTERNATIONAL SEARCH REPORT

Information on patent family members

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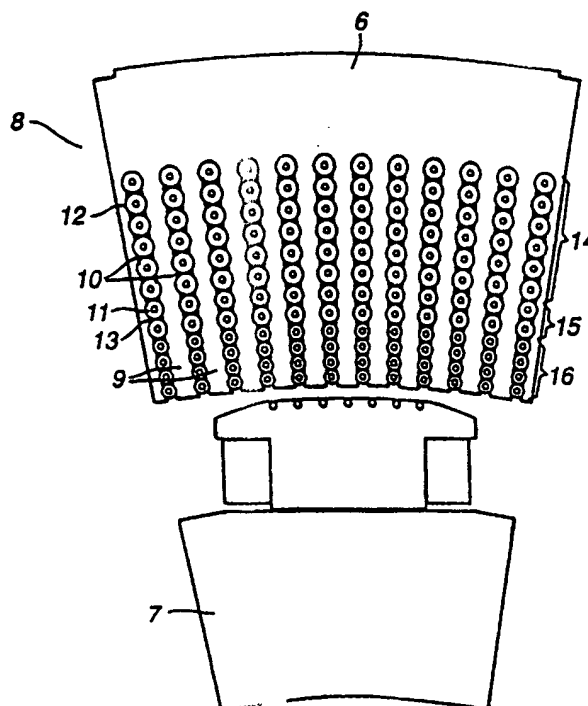
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Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5036165	A	30-07-1991	US 5067046 A	19-11-1991
			US 4853565 A	01-08-1989
			US 5066881 A	19-11-1991
			CA 1245270 A	22-11-1991
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US 4091298	A	23-05-1978	NONE	
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US 4330726	A	18-05-1982	NONE	
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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>6</sup> : <b>H02K 3/22, 55/04</b>	<b>A3</b>	(11) International Publication Number: <b>WO 99/29013</b> (43) International Publication Date: <b>10 June 1999 (10.06.99)</b>
<p>(21) International Application Number: <b>PCT/EP98/07738</b></p> <p>(22) International Filing Date: <b>30 November 1998 (30.11.98)</b></p> <p>(30) Priority Data: <b>9725316.5</b>      <b>28 November 1997 (28.11.97)</b>      <b>GB</b></p> <p>(71) Applicant (for all designated States except US): <b>ASEA BROWN BOVERI AB [SE/SE]; S-721 78 Västerås (SE).</b></p> <p>(72) Inventor; and (75) Inventor/Applicant (for US only): <b>LEIJON, Mats [SE/SE]; Hyvylargatan 5, S-723 35 Västerås (SE).</b></p> <p>(74) Agent: <b>NEWBY, Martin, John; J.Y. &amp; G.W. Johnson, Kingsbourne House, 229-231 High Holborn, London WC1V 7DP (GB).</b></p>	<p>(81) Designated States: <b>AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</b></p> <p><b>Published</b> <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p> <p>(88) Date of publication of the international search report: <b>19 August 1999 (19.08.99)</b></p>	

(54) Title: HIGH VOLTAGE ROTATING ELECTRIC MACHINES



## (57) Abstract

A rotating electric machine for direct connection to all types of high-voltage networks, in which the magnetic circuit adapted for high voltage comprises a rotor (7), stator (6) and at least one winding. The winding, or at least one of the windings, comprises cooled conductor means (3), preferably cooled superconducting means, surrounded by a solid insulation system (4).

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☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

\* Special categories of cited documents:

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Date of the actual completion of the international search

22 June 1999

Date of mailing of the international search report

30/06/1999

Name and mailing address of the ISA

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Kempen, P

# INTERNATIONAL SEARCH REPORT

Information on patent family members

Original Application No

PCT/EP 98/07738

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5036165	A	30-07-1991	US 5067046 A	19-11-1991
			US 4853565 A	01-08-1989
			US 5066881 A	19-11-1991
			CA 1245270 A	22-11-1991
US 4091298	A	23-05-1978	NONE	
US 4330726	A	18-05-1982	NONE	

CLAIMS

1. A high voltage rotating electric machine comprising a stator, a rotor and at least one winding having inner electrically conducting means and surrounding  
5 electrical insulation, characterised in that said electrically conducting means comprises conductor means and cooling means for cooling the conductor means to improve the electrical conductivity of the conductor means, and in that  
10 said electrical insulation is solid and comprises spaced apart inner and outer layers each having semiconducting properties and, between said inner and outer layers, an intermediate layer of electrically insulating material.

2. An electric machine according to claim 1, characterised in that the said semiconducting inner layer is  
15 electrically connected to, so as to be at substantially the same electric potential as, the conductor means.

3. An electric machine according to claim 1 or 2, characterised in that the said semiconducting outer layer is connected to a controlled electric potential along its  
20 length.

4. An electric machine according to claim 3, characterised in that the said semiconducting outer layer is connected to said controlled electric potential at spaced apart regions along the length of the outer layer.

25 5. An electric machine according to claim 3 or 4, characterised in that the said controlled electric potential is earth potential.

6. An electric machine according to claim 3 or 4, characterised in that the electric machine has more than one  
30 winding and in that a separate controlled potential is selected for each winding.

7. An electric machine according to any one of the preceding claims, characterised in that at least one of said semiconducting inner and outer layers has substantially the same coefficient of thermal expansion ( $\alpha$ ) as that of the  
5 said insulating layer.

8. An electric machine according to any one of the preceding claims, characterised in that each pair of adjacent layers of said electrical insulation are secured to each other along substantially their entire contact  
10 surfaces.

9. A high voltage rotating electric machine with at least one magnetic circuit comprising a magnetic core and a winding, characterised in that the winding comprises a cable having inner electrically conducting means comprising  
15 conductor means, and cooling means for cooling the conductor means to improve the electrical conductivity of the conductor means, and outer solid, e.g. extruded, electrical insulation comprising spaced apart inner and outer layers of semiconducting material and, between the inner and outer  
20 layers, an intermediate layer of electrically insulating material.

10. An electric machine according to claim 9, characterised in that the, or one of the, magnetic circuits is arranged in a stator of the rotating electric machine.

25 11. An electric machine according to claim 9 or 10, characterised in that the, or one of the, magnetic circuits is arranged in a rotor of the rotating electric machine.

12. An electric machine according to claim 9, 10 or 11, characterised in that the outer semiconducting layer is  
30 connected to earth potential at spaced apart regions along its length.

13. An electric machine according to claim 5, claim 7 or 8 when dependent on claim 5, or claim 12, characterised



in that, with connection of the outer semiconducting layer to earth potential, the electric field of the machine both in the slots and in the end winding region will be near zero.

5           14. An electric machine according to any one of the preceding claims, characterised in that the said conductor means comprises superconducting means.

10           15. An electric machine according to claim 14, characterised in that the cooling means comprises central tubular support means for conveying cryogenic coolant fluid, e.g. liquid nitrogen, and in that the superconducting means is of elongate form and is wound around the tubular support means.

15           16. An electric machine according to claim 14 or 15, characterised in that the said superconducting means comprises high-transition temperature superconducting (or HTS) material.

20           17. An electric machine according to claim 16 when dependent on claim 15, characterised in that the HTS material comprises HTS tape or wire wound around said tubular support means.

25           18. An electric machine according to any one of the preceding claims, characterised in that thermal expansion means are provided between the said electrically conducting means and the said surrounding electrical insulation.

          19. An electric machine according to claim 18, characterised in that said thermal expansion means comprises an expansion gap.

30           20. An electric machine according to claim 19, characterised in that the expansion gap comprises a void space.

21. An electric machine according to claim 19, characterised in that the expansion gap is filled with compressible material, e.g. foamed plastics material.

22. An electric machine according to claim 21,  
5 characterised in that the said compressible material includes electrically conductive or semiconductive material.

23. An electric machine according to any one of the preceding claims, characterised in that thermally insulating means is provided outwardly of the conducting means.

10 24. An electric machine according to any one of the preceding claims, characterised in that the or each winding is wound in slots formed in the stator or rotor, and in that each slot comprises a number of substantially circular  
15 cylindrical openings extending axially and radially outside one another, each pair of adjacent openings being joined by a narrower waist portion.

25. An electric machine according to claim 24,  
20 characterised in that the radii of the said openings of each slot decrease in a direction away from a yoke portion of a laminated core.

26. A high voltage rotating electric machine comprising a stator, a rotor and windings, characterised in that at least one winding comprises one or more coils and  
25 that the or each coil comprises conducting means having conductor means and cooling means for cooling the conductor means to improve the electrical conductivity of the conductor means, electrical insulation surrounding the  
conducting means and an equipotential outer layer  
30 surrounding a side and end of the coil.

27. An electric machine according to claim 26, characterised in that said conductor means comprises superconducting means.

28. An electric machine according to any of the preceding claims, characterised in that the rotating electric machine is connectable to one or more system voltage levels.

5           29. An electric machine according to claim 28, characterised in that one winding is provided with separate tappings for connection to different system voltage levels.

          30. An electric machine according to claim 28 or 29, characterised in that a separate winding is provided for  
10 connection to each system voltage level.

          31. An electric machine according to any one of the preceding claims, characterised in that the said intermediate layer is in close mechanical contact with each of said inner and outer layers.

15           32. An electric machine according to any one of claims 1 to 30, characterised in that the said intermediate layer is joined to each of said inner and outer layers.

          33. An electric machine according to claim 32, characterised in that the strength of the adhesion between  
20 the said intermediate layer and each of the semiconducting inner and outer layers is of the same order of magnitude as the intrinsic strength of the material of the intermediate layer.

          34. An electric machine according to claim 31 or 33,  
25 characterised in that the said layers are joined together by extrusion.

          35. An electric machine according to claim 34, characterised in that the inner and outer layers of semiconducting material and the insulating intermediate  
30 layer are applied together over the conducting means through a multi layer extrusion die.

36. An electric machine according to any one of the preceding claims, characterised in that said inner layer comprises a first plastics material having first electrically conductive particles dispersed therein, said  
5 outer layer comprises a second plastics material having second electrically conductive particles dispersed therein, and said intermediate layer comprises a third plastics material.

37. An electric machine according to claim 36,  
10 characterised in that each of said first, second and third plastics materials comprises an ethylene butyl acrylate copolymer rubber, an ethylene-propylene-diene monomer rubber (EPDM), an ethylene-propylene copolymer rubber (EPR), LDPE, HDPE, PP, PB, PMP, XLPE, EPR or silicone rubber.

15 38. An electric machine according to claim 36 or 37, characterised in that said first, second and third plastics materials have at least substantially the same coefficients of thermal expansion.

39. An electric machine according to claim 36, 37 or  
20 38, characterised in that said first, second and third plastics materials are the same material.

40. An electric machine according to any one of the preceding claims, characterised in that it is designed for use at high voltages, suitably in excess of 10 kV, in  
25 particular in excess of 36 kV, and preferably more than 72.5 kV up to very high transmission voltages, such as 400 kV to 800 kV or higher.

41. An electric machine according to any one of the preceding claims, characterised in that it is designed for  
30 use at a power range in excess of 0.5 MVA, preferably in excess of 30 MVA and up to 1000 MVA.

42. Use of a rotating electric machine according to any one of the preceding claims, characterised in that the

machine can be operated with up to 100% overload for a period of time exceeding 15 minutes and up to about two hours.

43. Use of a rotating electric machine according to  
5 any one of claims 1 to 41, characterised in that the rotating electric machine is directly connected to a power network via connecting devices and without an intermediate transformer between the machine and the network.

44. Use of a rotating electric machine according to  
10 any one of claims 1 to 41, characterised in that voltage regulation of the rotating electric machine is performed by control of the magnetic field flow through the rotor.

45. Use of a rotating electric machine according to  
15 any one of claims 1 to 41, characterised in that the machine can be operated without mechanical load and that the machine is provided for compensation of inductive or capacitive load on the network.

1/1

Fig. 1

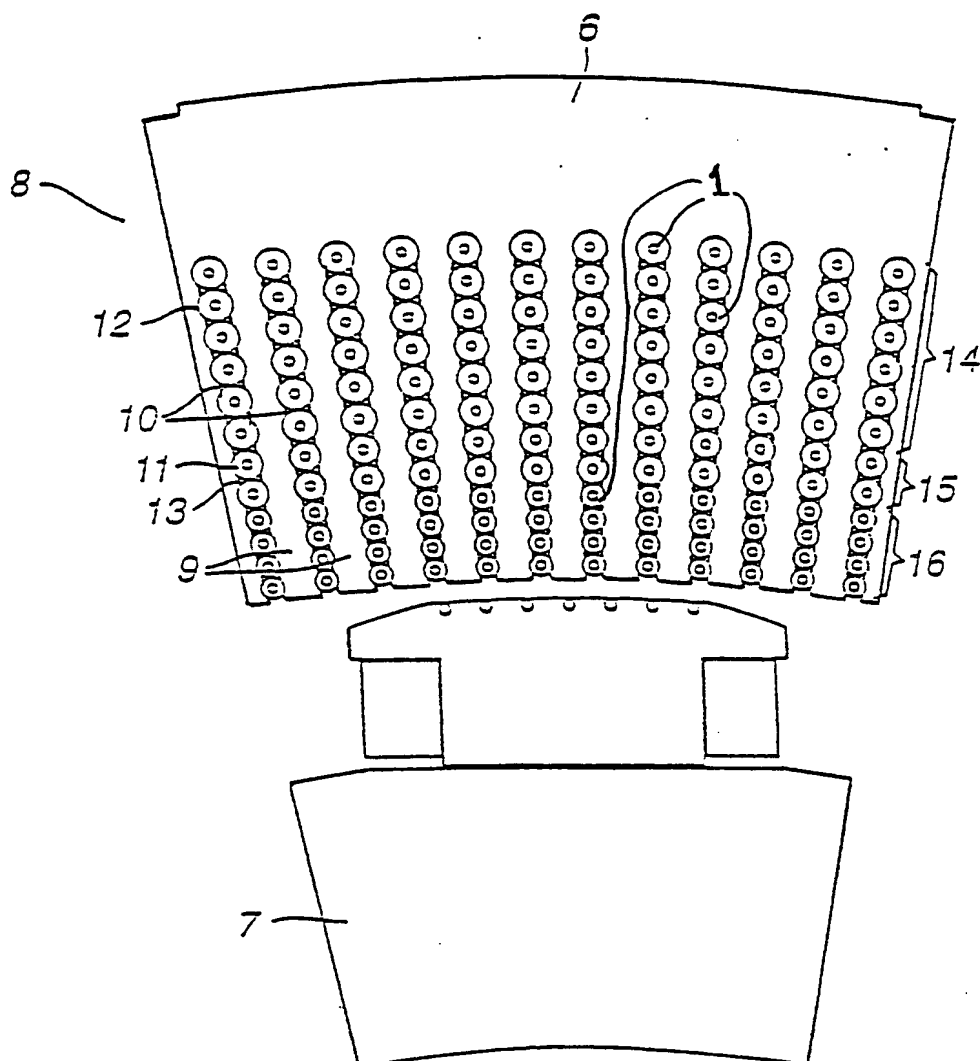
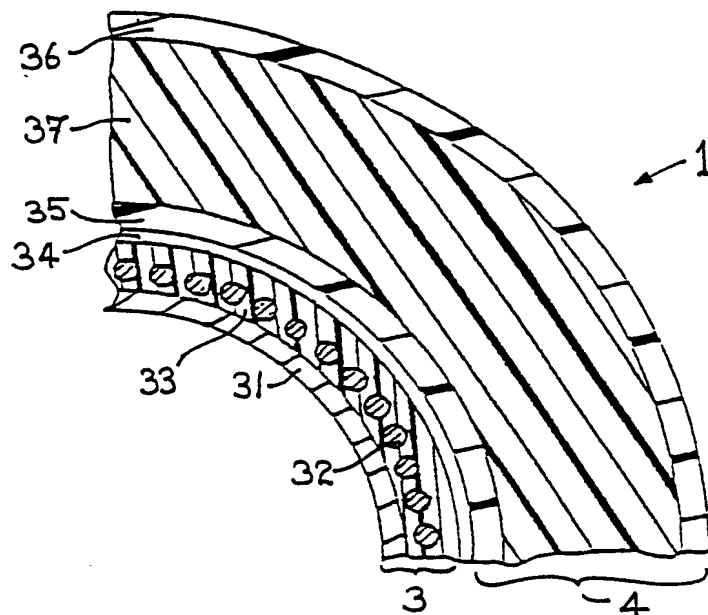


Fig. 2

CURRENT SHEET (1/1)

ART 34/AMDT